NW100 Acoustic Noise

A03008

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Approved Use

External Use - No NDA Required	**X**
Internal Use Only	

Revision History

Revision	Date	Description of Change
A	6/9/2010	Initial Release
B	6/15/2010	Addition of 8 m/s data, clarification of references.
C	6/29/2010	NDA not required for external use.
D	7/30/2010	Addition of 10 m/s data, minor updates.
E	11/17/2010	Addition of measurement procedure information, minor updates

Contents

1 Introduction and Discussion of Noise Calculations

1.1 Purpose

The purpose of this document is to characterize the acoustic noise of the NW100 wind turbine based on third party measurements and a standard formula for projecting sound pressure at a given distance.

1.2 Introduction

When using this projection the following concepts are important background information.

- Sound power is the amount of sound being produced at a source.
- Sound pressure is the observed noise level at a given location.

The sound power of a source can be used to calculate the sound pressure at a particular location using a known relationship.

The measurement of sound power was conducted by a third party (DNV-GEC) and is based on data from turbines at two sites on a standard NW100. Measurements were taken according to IEC 61400-11. This standard uses a 10m reference height for wind speed.

As part of our ongoing product improvement and validation efforts Northern Power will update this document to reflect changes in acoustic performance as needed.

1.3 Discussion of Noise Calculation

Based on third party measurements an apparent sound power level at the turbine has been calculated. These values are 96.7 dB(A) at a wind speed of 6 m/s, 100.8 dB(A) at a wind speed of 8 m/s, and 102.3 dB(A) at 10 m/s. These sound power numbers can be converted into sound pressure using the following equation[1]:

$$L_p = L_w - 10\log_{10}(2\pi R^2) - \alpha R$$

Where:

L_p = Sound Pressure

L_w = Apparent Sound Power

R = Slant Distance, which is the diagonal distance from the turbine nacelle to the location of concern on the ground. This can be calculated using the Pythagorean Theorem.

α = broadband sound absorption coefficient, generally assumed to be 0.005 dB(A)/m

[1] From: *Wind Turbine Acoustic Noise*, Renewable Energy Research Laboratory, J. Manwell, S. Wright, 2006.

2 Appendix A - Calculated Sound Pressure vs. Radial Distance

6 m/s wind speed, 37m tower

Radial distance from tower (m)	Radial Distance from Tower (ft)	Sound Pressure (dB(A))
1	3.3	57.2
5	16.4	57.1
7.63	25.0	57.0
10	32.8	56.9
15	49.2	56.5
20	65.6	56.0
25	82.0	55.5
30	98.4	54.9
35	114.8	54.3
40	131.2	53.7
45	147.6	53.1
47.5	155.8	52.8
50	164.1	52.5
60	196.9	51.4
75	246.1	49.9
100	328.1	47.6
125	410.1	45.8
150	492.2	44.2
175	574.2	42.8
200	656.2	41.5
225	738.2	40.4
250	820.3	39.4
275	902.3	38.5
300	984.3	37.6
325	1066.3	36.8
350	1148.4	36.0
375	1230.4	35.3
400	1312.4	34.6
425	1394.4	34.0
450	1476.5	33.4
475	1558.5	32.8
500	1640.5	32.2

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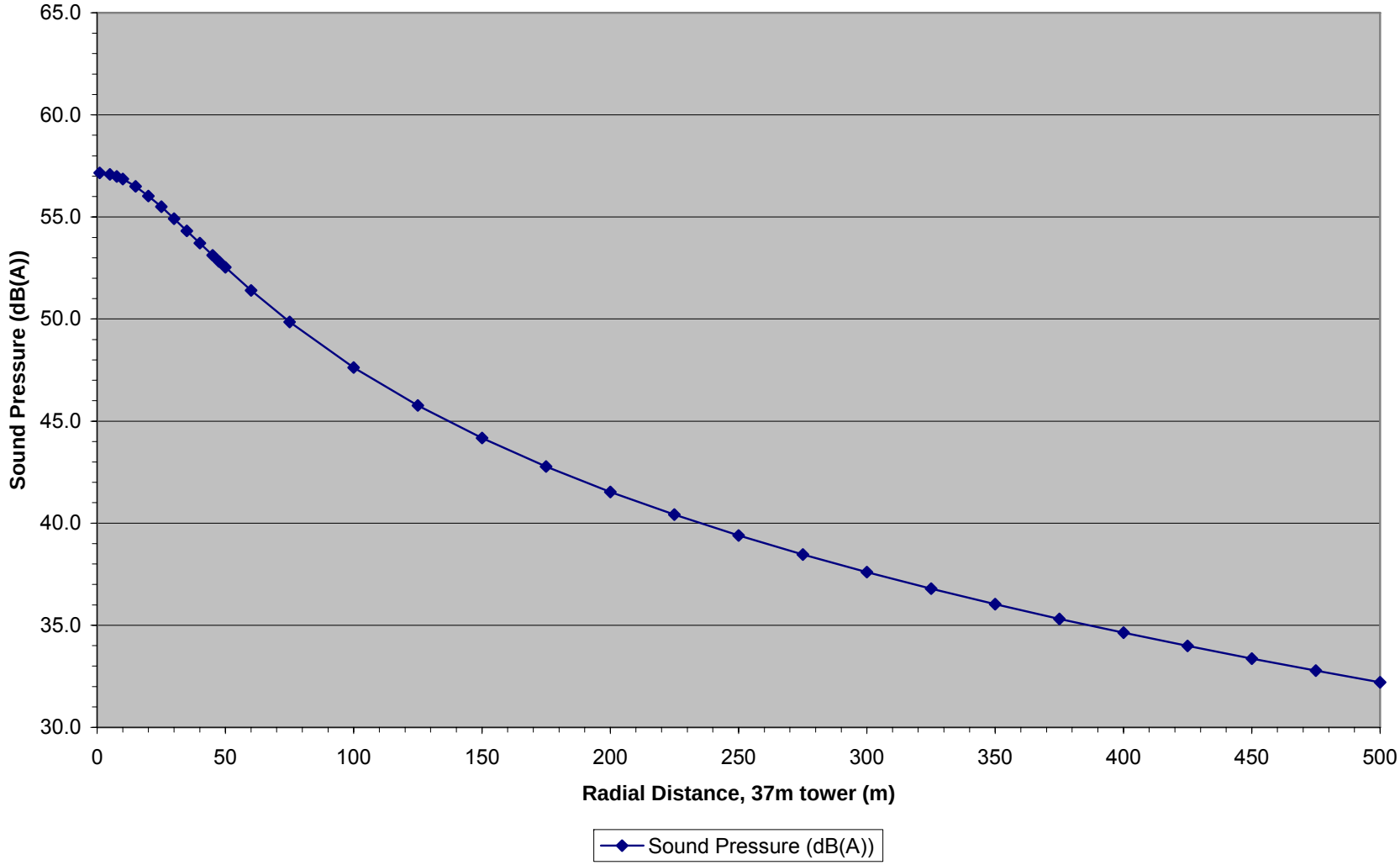
Sound Pressure vs. Distance, 6 m/s



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8 m/s wind speed, 37m tower

Radial distance from tower (m)	Radial Distance from Tower (ft)	Sound Pressure (dB(A))
1	3.3	61.3
5	16.4	61.2
7.63	25.0	61.1
10	32.8	61.0
15	49.2	60.6
20	65.6	60.1
25	82.0	59.6
30	98.4	59.0
35	114.8	58.4
40	131.2	57.8
45	147.6	57.2
47.5	155.8	56.9
50	164.1	56.6
60	196.9	55.5
75	246.1	54.0
100	328.1	51.7
125	410.1	49.9
150	492.2	48.3
175	574.2	46.9
200	656.2	45.6
225	738.2	44.5
250	820.3	43.5
275	902.3	42.6
300	984.3	41.7
325	1066.3	40.9
350	1148.4	40.1
375	1230.4	39.4
400	1312.4	38.7
425	1394.4	38.1
450	1476.5	37.5
475	1558.5	36.9
500	1640.5	36.3

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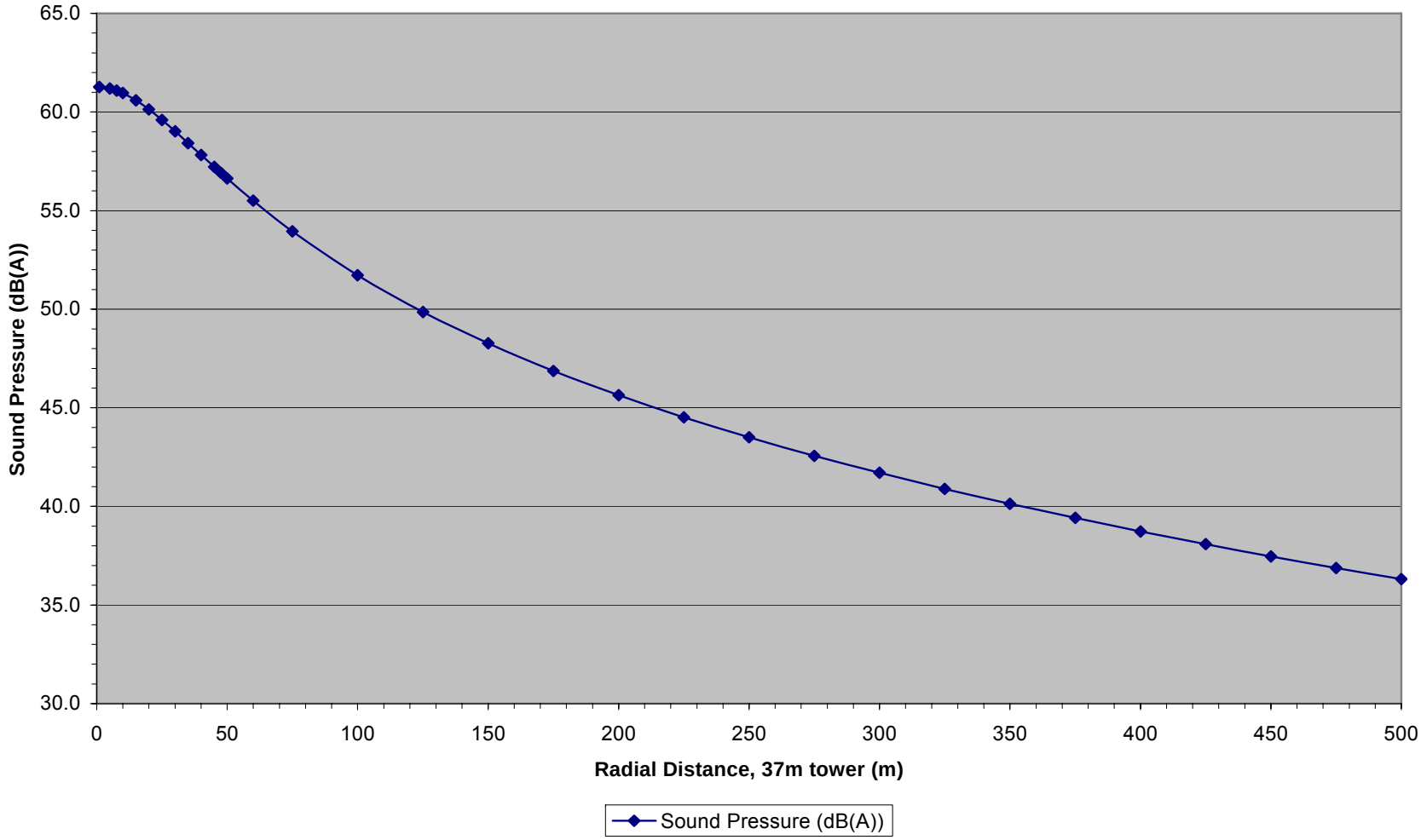
Sound Pressure vs. Distance, 8 m/s



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10 m/s wind speed, 37m tower

Radial distance from tower (m)	Radial Distance from Tower (ft)	Sound Pressure (dB(A))
1	3.3	62.8
5	16.4	62.7
7.63	25.0	62.6
10	32.8	62.5
15	49.2	62.1
20	65.6	61.6
25	82.0	61.1
30	98.4	60.5
35	114.8	59.9
40	131.2	59.3
45	147.6	58.7
47.5	155.8	58.4
50	164.1	58.1
60	196.9	57.0
75	246.1	55.5
100	328.1	53.2
125	410.1	51.4
150	492.2	49.8
175	574.2	48.4
200	656.2	47.1
225	738.2	46.0
250	820.3	45.0
275	902.3	44.1
300	984.3	43.2
325	1066.3	42.4
350	1148.4	41.6
375	1230.4	40.9
400	1312.4	40.2
425	1394.4	39.6
450	1476.5	39.0
475	1558.5	38.4
500	1640.5	37.8

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Sound Pressure vs. Distance, 10 m/s